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ABSTRACT

Two experiments assessed the effect of vocabulary difficulty on three measures of text comprehension--free recall, summary recall, and sentence recognition. In the first experiment, the effect of differing proportions of rare-word substitutions were examined in 79 sixth grade students. It was found that a high rate of difficult vocabulary (one substance word in three) was required before reliable effects on comprehension were evident. In the second experiment, difficult vocabulary was placed in important text elements in one form of the passages, and in unimportant elements of another form of the passages that 71 sixth grade students read. These two forms were contrasted with easy vocabulary forms in their effects on three comprehension measures (total recall, summarization, and sentence recognition). Only on the summary measure was there an overall effect for difficult vocabulary in important elements. These experimental results may be explained by the "minimum effort principle" in reading. That is, a reader will avoid deep processing of difficult or unfamiliar words as much as possible, without loss of the main themes of the passage being read. The "minimum effort principle" also would predict that the presence of difficult words in important propositions would result in substantial losses at the point of comprehension. (RL)

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Technical Report No. 202

EFFECTS OF DIFFERING PROPORTIONS AND LOCATIONS OF DIFFICULT VOCABULARY ON TEXT COMPREHENSION

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May 1981

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Abstract

Two experiments assessed the effect of vocabulary difficulty on three measures of text comprehension--free recall, summary recall, and sentence recognition. In Experiment 1 the effects of differing proportions of rare-word substitutions were examined. It was found that a high rate of difficult vocabulary (1 substance word in 3) was required before reliable effects on comprehension were evident. In the second experiment, difficult vocabulary was placed in important text elements in one form of the passages, and in unimportant elements in another. These were contrasted with easy vocabulary forms in their effects on the three comprehension measures. Only on the summary measure was there an overall effect for difficult vocabulary in important elements. The results are discussed in terms of the salience of the signaling value of unfamiliar words.

Effects of Differing Proportions and Locations of Difficult Vocabulary on Text Comprehension

The experiments reported here examine the role of vocabulary difficulty in reading comprehension. Correlational studies have consistently found that vocabulary knowledge is strongly related to both general verbal ability and reading comprehension (e.g., Davis, 1944, 1968; Thorndike, 1973). Thorndike, for instance, collected data from over 100,000 students in three age groups from 15 countries and found median correlations between vocabulary knowledge and reading comprehension of .71 (10-year-olds), .75 (14-year-olds), and .66 (18-year-olds). Thorndike concluded that reading performance is "completely . . . determined by word knowledge" (1973, p. 62).

Analyses of readability (e.g., Bormuth, 1966; Coleman, 1971; Klare, 1974-75) have also demonstrated the pre-eminent relationship of word knowledge to comprehension measures. In the Dale-Chall (Dale & Chall, 1948) readability formula, for example, the weighting of the word difficulty factor is about four times greater than that of any other index.

Findings from experimental studies on the relationship between vocabulary and text comprehension, however, have been equivocal. Wittrock and his colleagues (Marks, Doctorow, & Wittrock, 1974; Wittrock, Marks, & Doctorow, 1975) found that on multiple choice tests of comprehension, the performance of sixth grade students was lowered

when about 15% of the substance words in a passage were replaced by rare synonyms. This effect was consistent across passages above, below, and equal to the reading level of the students. The authors concluded that knowledge of individual word meanings is vitally involved in the comprehension process.

There are studies, however, which have failed to establish this direct relationship between vocabulary difficulty and comprehension. Tuinman and Brady (1974) pretested fourth-, fifth-, and sixth-grade students on grade appropriate materials chosen from the comprehension subtests of the California Achievement Test, and on a subset of the difficult words in the passages. They then trained the students on these using a range of self-paced exercises (definitions, examples, use in context, etc.) and posttested both vocabulary and comprehension with the same materials. Tuinman and Brady found that the instructional program resulted in an increase in students' performance on the vocabulary test by an average of about 20%. For the comprehension measure, however, pre- and post-test means were almost identical. These were about 60% for both tests, so the effect was not due to a ceiling on performance.

Jenkins, Pany, and Schreck (1978) reported results compatible to these. They used a number of instructional methods to increase the vocabulary knowledge of fifth- and sixth-grade students. This increase was significant, but there was no transfer to comprehension of discourse containing the words taught. The group receiving instruction was able to

perform no better on a cloze test or in free recall than a control group who definitely did not know the words.

There are a number of possible explanations for the discrepancy between the results reported above. Among the major candidates are that the passages differed in length and degree of word difficulty, and that the differing dependent measures led to different findings. Two other hypotheses are examined here. First, it may be that the proportion of substance words that were difficult vocabulary in the running prose created difficulties. Jenkins et al. did not specify the proportion of substance words that were difficult in their passages, whereas Marks et al. claimed that about 1 in 6 or 7 of the words in their passages were difficult, as indexed by low frequency. In the first experiment reported here, comprehension of passages containing only easy vocabulary is compared with comprehension of passages with two levels of rare-word substitution. The substitution rates are 1-in-6 and 1-in-3 of the substance words.

A second hypothetical explanation for the discrepant experimental findings concerning vocabulary difficulty and reading comprehension is that in the passages used the difficult vocabulary appeared in propositions having differing levels of importance in the text. A proposition can derive importance from a number of sources. A reader's background knowledge can cause particular propositions to be highlighted during processing (Steffensen, Jogdeo, & Anderson, 1978); the height of a

proposition in the ideational hierarchy of a text relates to its importance (Meyer & McConkie, 1973); and authors can signal important items blatantly (Rothkopf & Bisbicos, 1967). All of these sources of importance are related to increased recall of highly important propositions (Johnson, 1970).

It is hypothesized that difficult vocabulary minimizes the probability that the proposition containing that vocabulary will be comprehended. It is further assumed that important propositions serve as "major conceptualizations" (Schank & Abelson, 1977) and thus as aids to recall of the less important related propositions. Thus, the appearance of difficult vocabulary in important propositions should cause an overall decrease in performance on free-recall, summarization, and recognition tests of comprehension. An equal proportion of difficult vocabulary appearing in propositions judged to be trivial in the text should not lead to such decrements in performance. The second experiment tests this hypothesis.

Experiment 1

In this experiment, children completed three comprehension measures on texts that were either written in generally high frequency vocabulary or had 1 substance word in 6 or 1 in 3 changed to a rare synonym.

Method

Subjects. Participating in the study were 105 sixth-grade students from a suburban district in northern California. These students comprised

the entire sixth grade in two schools in predominantly lower-middle and middle class areas. Of these 105 students, 79 completed all the experimental tasks. Standardized stanine scores on vocabulary, reading comprehension, spelling, language expression, and total language measures were available for 72 of these 79. For the whole of the United States, these stanine scores have a mean of 5.00 and a standard deviation of 2.00. In this sample, the means ranged from 5.14 to 5.50, and the standard deviations from 1.57 to 1.91.

Materials. Five passages were selected from the Scott-Foresman Grade Six Social Studies text. The passages were 400-500 words long, or were condensed to this length where necessary. In addition, four passages were written for the experiment. These were two familiar/unfamiliar-topic pairs. Each familiar/unfamiliar pair was identical in sentence construction and in all but the substance words necessary to change the topic. The five Social Studies passages represented a range of topics. Three were general descriptions about energy use, the environment, and sea life, respectively. One was concerned with the natural resources of Costa Rica, and the fifth with the governmental history of Sweden. Of the four passages written for the study, the two familiar topics were a visit to a supermarket, and a game of horseshoes; the unfamiliar topics were a visit to Niugini sing-sing, and a description of an Indian game called huta. These were of approximately the same length and syntactic and lexical difficulty as the Scott-Foresman passages.

It was decided on the basis of the findings of Marks, Doctorow, and Wittrock (1974) that vocabulary difficulty would be examined in three conditions. The "easy" condition comprised the high word-frequency form of the passage; the "medium" condition entailed the substitution of approximately 1 substance word in 6 in the easy condition with a low-frequency synonym; the "difficult" condition entailed such substitutions for 1 substance word in 3. These conditions were constructed in a mechanical way. The proportion of substance words in the passages (.53) was estimated from a 100-word sample from each passage (first and last 50 words). It was then determined how many substance words per line needed to be changed for the difficult condition. Each line was then scanned for substance words amenable to replacement. Through the use of a thesaurus, the difficult versions of each passage were constructed with rare words, the frequency of which was checked a posteriori.

All the substitutions entailed pairs of words that were felt, by intuition, to be substantially divergent in their frequency of occurrence in normal language. A posteriori analysis revealed that the substituted common words were significantly higher in frequency than the rare substitutions, as assessed by Standard Frequency Index values from Carroll, Davies, and Richman (1971). The mean for the common words was 62.19 (SD = 8.12), while the mean for the rare words was 41.07 (SD = 13.89). A one-tailed t test indicated that this difference is highly significant (t = 38.44, df = 592, $p < .01$). Only two of the 593 pairs entailed

frequency differences that were in the wrong direction. The differences were very small in these two instances.

The familiarity of the low-frequency words to the sixth-grade students was checked through the administration of a vocabulary test containing the words the subject was later to read in the passages. The format of this test has been suggested by Anderson and Freebody (1979) and yields a reliable estimate of word knowledge, corrected for responses on the basis of partial knowledge. Analysis indicated that subjects had some knowledge of 44.4% of the rare substitutes (SD = 17.6). The subjects were divided into three groups on the basis of overall achievement test scores. After correction, higher-ability students indicated some knowledge of 53.7% of the words (SD = 13.1), middle-ability students knew 42.9% (SD = 15.0), and lower-ability students knew 31.7% (SD = 17.1). This test probably predicts a liberal measure of knowledge of word meaning, and these percentages were felt to be adequate for the purposes of the experiment. Those low frequency words that more than 75% of the subjects knew were identified for change, where possible, in the second experiment.

It should be noted that the students' familiarity with the high frequency words which were substituted was not checked. Thus, use of the term "easy" needs to be considered as contrasting with "rare," rather than as relating directly to the students' facility with the words.

Design and procedures. The nine passages were arranged in three 3-order Latin squares. The passages were grouped in threes, and subjects

were randomly assigned to the rows of the square, each subject reading three stories, one in each vocabulary condition. Number of students per row ranged from 7 to 10.

After reading each passage, subjects were asked to complete a number of tasks. Immediately after reading, they were presented with a multiple-choice vocabulary item not related to the passages. This acted simply as an interval filler, to minimize rote recall of words appearing late in the passage. Subjects were then asked to free-recall the passage. The instructions indicated that they should use the exact words that were in the passage, or if they could not remember these they were to use their own words to express as many of the ideas they could remember from the passage. These instructions were typed at the head of a blank page. Having completed their recalls, the subjects were asked, on the following page, to write a 2 to 3 sentence summary of the main ideas in the passage.

The sentence recognition task followed the summarization task. These sentences were developed from a consideration of the important and peripheral ideas in the passages. Four propositions judged to be important and six judged to be unimportant were expressed in sentences in which manipulated substance words were written in a third form, different from both the familiar and the unfamiliar vocabulary conditions. In addition, three foil sentences were included. These were somewhat outlandish and included ideas that were not touched upon in the passage. Half of the

important and peripheral sentences were expressed in a form contrary to that of the original. Thus, there were 2 true and 2 false important-idea sentences and 3 true and 3 false peripheral-idea sentences, plus 3 false foils. The subjects were instructed to read each sentence carefully and to decide whether or not the idea expressed in that sentence was in the passage they just read. They were then to check a "yes" or a "no" box.

This entire procedure was repeated after each passage. It was emphasized that the students could read the passage more than once, but having turned to the filler item, could not look back at the passage.

The students were tested in their intact classroom groups during their reading periods. The purposes of the study were explained to them at the outset of the vocabulary sessions. The vocabulary sessions were conducted about a week before the comprehension tests. The students were assigned to a square in the design at the point of the vocabulary tests. They worked at their own rates, and consequently, there was some variation in completion times.

Scoring

Free recall. The problem of the scoring of recall protocols is partly the problem of what unit of language is to be used. In this study, a liberal definition of a proposition was used in the analysis of the passages. Essentially a proposition was stipulated to be a clause or phrase which expressed a separable idea. Such clauses or phrases might

be temporal, spatial, or conditional modifiers, or simply principal clauses. Conjunctions joining such units marked new propositions but conjunctions joining aggregations subsumed under a proposition did not. In addition, in order to be considered a separate proposition, it had to introduce information which is essentially new in the discourse. This newness requirement stipulates that when a clausal unit is appearing for a second time solely for the purpose of modification or extension, it does not again constitute a separate proposition. Through the use of these criteria, it was hoped that reliability of scoring the location of the recalled proposition would be enhanced. On the basis of this procedure, it was found that the nine stories contained between 37 and 51 propositions, with a mean of 43.56 ($\underline{SD}$ = 3.21).

Separate scores for each student were taken, on the free recall measure, of verbatim and paraphrased recall and compatible and incompatible intrusions. Verbatim and paraphrased propositions and compatible intrusions were combined to produce the free recall scores used in the analysis. Compatible intrusions include summary statements, elaborations based on prior knowledge, or unconnected fragments of propositions.

With these categories, two independent raters scored 84 protocols, which were the performance of the first 33 students tested (some students did not complete all three passages). Agreement ratings were then determined. The agreement rate for the three total scores (verbatim, paraphrase, intrusion) of each subject on a passage was .96 (279/292).

Points of disagreement were then examined and resolved in order to establish scoring policies.

Summaries. The criteria for scoring summaries were developed empirically. Easy versions of the passages were given to five adults. They were asked to read each passage carefully and then to write a brief (i.e., 3-4 sentence) summary immediately after reading. The students' summaries were scored on the basis of their inclusion of those propositions which appeared consistently in the adult summaries. No account was taken of the relative standing of these propositions: One point was given to the student if one of these propositions, or an acceptable paraphrase, was included in the summary. Due to the fact that slightly different numbers of propositions appeared regularly in the adult summaries for different stories, a proportional score was awarded, and for the final analysis, the arcsine of this proportion was taken as the criterion measure.

Sentence recognition. Students were given a point if they correctly confirmed a true statement or rejected a false one. No points were awarded for the correct rejection of the three dummy items in each exercise, nor was any correction made for guessing or "yes"-proneness, since equal numbers of "yes" and "no" responses were required, and every subject responded to all items in a forced-choice mode. Thus, each student was awarded a raw score out of 6 for recognizing trivial proposition and out of 4 for important propositions for each passage.

Multiple regression analysis was used to partition the variance in this experiment. The between-subjects variance was analyzed by the regression of the between subjects factors on the mean scores for each measure. Within-subjects effects were analyzed in a separate regression with hierarchical inclusion of the variables proceeding in the following order: main effects for within-subjects effects, within-subjects interactions of interest, between-subjects main effects and interactions, between-by-within-subjects interactions of interest following the procedure outlined by Cohen and Cohen (1975). All two-way interactions and only those three-way interactions containing combinations of generalizable factors were included. Variance attributable to interactions of no general interest was relegated to the error term. For this experiment, it was decided to code the passage factor and include some of its interactions in the analysis. Others of these were relegated to the residual term. Passage and group were represented by dummy codes. More detailed rationale for this general form of analysis is provided by Cohen and Cohen (1975), chapter 10. The critical values of F were attained with conservative degrees of freedom. In both experiments, the degrees of freedom of the denominator will be based on the assumption that the within-subject measures are not independent. That is, the denominator for critical values of F will be n, rather than the divisor of the residual term.

Results and Discussion

Table 1 contains the summarized results of this experiment. The means and regression weights for the two effects of interest, ability, and vocabulary difficulty, are presented in Table 2. It can be seen that the incidental design factors (square and row or group) were not associated with significant effects on any of the measures. Strong ability (as assessed by total language stanine scores) differences were evident, and in the predictable direction. These are reported as regression weights, since the variable is continuous. The weight for recall, for instance, indicates that for every unit increase in stanine score an increase of 1.24 propositions is predicted in the recall protocol.

Of major interest in this initial study is the main effect for vocabulary difficulty on measures of retention. This variable had a statistically significant effect on only one measure, the total recognition score. On two of the other measures, the total recall score and the main-idea recognition score, the amount of variance accounted for tended toward significance (both p values < .10). From the table of means it can be seen that the means are in the predicted direction for each of the retention measures.

Insert Tables 1 and 2 about here.

A number of factors may have detracted from the clarity of the effect for vocabulary difficulty on the measures. First, the effects

of the medium-difficulty condition (i.e., 1 substance word in 6 replaced by a low-frequency synonym) were erratic. The means for each passage in each vocabulary condition are presented in Table 3. It can be noted that for all passages but one, the means associated with easy vocabulary condition were higher than those for difficult vocabulary. The exception entails only a small difference. However, it is clear that the medium vocabulary condition is associated with a variety of effects.

The inconsistent effects of a rare-word substitution rate of 1 in 6 are worth consideration. It might by hypothesized that vocabulary difficulty imposed some strain on the reader but that this strain was so light that any appropriate contextual assistance available could overcome it and permit a workable representation of the meaning to be developed. This contextual assistance may have been differentially available in different passages and at different points in a passage. Hence the inconsistent effects. Similarly, the low rate of substitution may have resulted in important information being obscured in some cases and not in others. It might even be the case that the appearance of unfamiliar vocabulary in trivial propositions caused the students to skip those and concentrate on more important propositions, resulting not only in less information to be processed, but more mnemonically useful information at that. This question is addressed in the following experiment.

Insert Tables 3 and 4 about here.

Another factor detracting from the clarity of the effects is the relegation to the error term of variance due to the order in which passages were read. A post hoc examination of the means indicated that position effects were not trivial. In addition, some interactions between vocabulary difficulty and position were suggested. The means for this effect are presented in Table 4. Similarly, variance attributable to the interactions of other "nuisance" variables (e.g., story, group, position, square) was contained in the error term in this analysis, probably accounting in part for the size of that term, particularly in the total recall and detail recognition analyses. These factors are included in the analyses in the following experiment.

Thus, in an attempt to examine the effects of vocabulary difficulty on retention in a broad-stroke manner, over a large number of school-based comprehension tasks, only a measure of sentence recognition displayed a significant effect in the predicted direction. In the following experiment an attempt will be made to test one possible explanation of the unclear findings--that is, that the effects of difficult vocabulary depend upon some characteristic of the propositions in which the difficult words appear.

Experiment 2

This experiment was designed to test the hypothesis that difficult vocabulary appearing in important propositions in a passage would lead

to significantly lower retention levels than easy vocabulary forms in which difficult vocabulary appeared in trivial propositions. The test formats of the first experiment were retained. The importance level of a proposition was ascertained empirically. Students completed total recall, summarization, and sentence recognition tasks after reading each passage.

Method

Subjects. Seventy-one sixth-grade students from a small city in central Illinois comprised the sample. Stanine scores for the students were above the national average with less than average variation. Reading comprehension mean stanine score was 5.76 (*SD* = 1.85), and mean total language stanine score was 6.01 (*SD* = 1.90).

Materials. Three passages were selected from those used in Experiment 1 which were felt by intuition, to have fairly clear importance structures. Importance ratings for each proposition were gained from a separate, equivalent sample of 30 sixth-grade students. These students were presented with two passages each; they read through each passage and then rated the importance of each proposition on a three-point scale. Next to each proposition were three boxes; a large, a medium-sized, and a small box indicating high, moderate, and low importance, respectively. Students were instructed to read the story carefully, then turn over the page and judge whether each separate idea from the story was very important, "sort-of" important, or not at all important.

These data were scored by awarding to each proposition a score of 3 for a judgment of high importance, 2 for moderate importance, and 1 for low importance. These were summed across all subjects, and each proposition was assigned a mean importance rating. On the basis of these values, the highest and lowest one-fourth of the proposition were identified.

The identification of propositions of high and low importance allowed the generation of three versions of each passage. An "easy" form of each passage contained only high-frequency words, a "difficult-unimportant" version contained difficult vocabulary substitutions in each of the low importance propositions, and a "difficult-important" version contained substitutions in each of the propositions ranked as highly important.

In order to increase the necessarily lower rate of difficult substitutions it was often the case that more than one word in each proposition selected for manipulation was changed in the difficult versions. This was not always possible, and thus the replacement rates of low frequency substitutions of substance words for the three passages were 1 in 7.9, 9.0, and 9.85.

Design and procedure. Three forms of the three passages were constructed and arranged in a three-order Latin Square. Each student read one passage in each of the three vocabulary forms. Students were assigned at random to one of the three rows of the Latin Squares. Order of presentation was counter-balanced within each row. All tests were

administered to students in their intact class groups. Sample sizes per row were 22, 24, and 25. Instructions, procedures, and scoring policies were identical to those used in Experiment 1.

Results and Discussion

All two-way interactions were included in the analysis except for the passage x position effect. Position x vocabulary x ability was the only three-way effect included. Variance attributable to higher-order effects was relegated to the pooled residual. Two contrasts were constructed specifically to test the importance and vocabulary manipulations separately. Thus, easy vocabulary was contrasted with the mean on the other two forms. Forms with difficult vocabulary in the important versus the unimportant forms constituted the importance contrast.

The partitioning of variance and significance tests for the three dependent measures are presented in Table 5. Table 6 contains the regression weights and means of interest. No main or interaction effects of group were evident. Two-way interactions not included in Table 5 accounted for nil variance. The passage variable was associated with a significant proportion of the variance, as in Experiment 1. The vocabulary and importance manipulations are of major interest in this experiment. Tests of the significance of the contrasts are presented separately in both the summary table, Table 5, and the tables of means, Tables 6 and 7.

Free recall. Table 5 indicates that verbal ability of the students and the particular passage used are strong predictors. The effects of

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Insert Tables 5 and 6 about here.

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vocabulary difficulty at various importance levels, however, are not simple, but involve a number of interactions. Essentially, while the main effect for vocabulary is significant, important interactions were found with position and ability which prohibit clear interpretation of the main effect. Thus, it needs to be concluded that the effects of these levels of vocabulary difficulty were unclear if we ignore for the moment the location of that difficulty in the text.

Similarly, effects due to the importance manipulation on the free recall measure were clouded by an interaction with position. When difficult vocabulary was located in unimportant propositions, there was a pronounced advantage for the first position over the other two. Second and third position performance was close to identical. When difficult vocabulary appeared in important propositions, there was some increase in recall from first to second position and a substantial increase from second to third. These differences are not readily explicable.

Summaries. The findings were clearer for summaries. It can be seen from Table 5 that the versions containing difficult vocabulary in unimportant propositions led to the students' providing much more adult-like summaries. This clear finding is consistent with the notion that when

the reader encounters an unfamiliar word, he or she usually decides to skip that word and process whatever is more accessible. When these unfamiliar words are in unimportant propositions in a text, the more important portions of the text with the more familiar words are processed. This permits, by hypothesis, a lighter load in terms of length and, mnemonically, a more useful set of information, with the main points more evident. When difficult words are in important propositions, the information which is processed is less likely to allow the generation of an appropriate summary.

For each passage in each form, an analysis was conducted to test whether particular propositions appeared more in one vocabulary form than another. A significant proposition effect was found for each passage ($p < .02$ for all passages). No significant vocabulary x proposition effects were found. The mean values of the students' inclusion rates for each adult-included proposition are presented in Table 7.

It is instructive to speculate about the characteristics of those propositions which were included by adults but not by the students. In the first passage, "Fuels," the three propositions that were more consistently included form a closely knit sequence: we rely on these fuels; we are running out of them; (so) we are devising new energy sources. The rarely included item is stressed equally in the passage, but presumably does not relate in the same necessary way to the recent testing of possible new energy sources, the description of which takes

up much of the passage. That is, the fuels we use have presumably always been as dangerous as they are now. Therefore, this does not explain the recent flurry of experimentation.

Insert Table 7 about here.

The second passage was associated with a pattern of summaries which are more difficult to speculate about. The pollution of the oceans was often included, and its apparent close neighbor, the need to stop, was not. A possible explanation is that the statements of the oceans' importance and of our pollution of the oceans carry the strong implication that the pollution should stop. Thus, the students may have omitted it as obvious.

The third passage, "Costa Rica," contains a description of Costa Rica's location, its discovery by Columbus, its rich agricultural resources, and its undeveloped riches. The passage concludes with a brief list of Costa Rica's import needs. Students generally did not produce a high proportion of adult-like summaries. Most of the passage is concerned with the agricultural wealth of Costa Rica, and this notion is the one most included in students' summaries. The least included, the undeveloped resources of Costa Rica, also takes up a sizeable portion of the passage, so it is not obvious why students would include it less often. One characteristic of students' summaries of this third passage was that they tended to include some detailed information appearing

earlier in the story. As a literary device, the author of this passage has described Columbus' discovery of Costa Rica and his frequent meetings with gold-bedecked Indians in that area. The author then mentioned that Columbus thought he had arrived in an area of fabulous wealth because of the amount of gold he saw, but that the real wealth of Costa Rica is her soil. With this twist, the current agricultural economy of the country is introduced and then described. Students seemed overly occupied with including the date of Columbus' arrival, the fact that it occurred on his fourth trip to the Americas, and other details. Only two of the adults mentioned Columbus at all, apparently realizing that his main function in the passage was as an introductory device.

In overview, students produced more adult-like summaries to those forms of the passages which contained difficult vocabulary in the unimportant propositions and less adult-like summaries when difficult words were placed in important propositions. Propositions varied in the likelihood of their inclusion by students in summaries. An interpretation of patterns of inclusion is offered: Students' summaries differed from the adults' summaries in their tendencies to focus on particular themes in the text, to leave automatic inferences unstated, and to include salient but structurally insignificant details.

Sentence recognition. The effects of vocabulary difficulty and importance levels on recognition, as indicated in Table 5, were again unclear. Effects were either in an unpredicted direction (importance) or clouded by interactions with position.

Proportions of correct responses to each recognition item in the three vocabulary conditions were examined in an effort to identify specific vocabulary-related effects. There were few clear differences related to vocabulary. Those items showing such differences, and the values for each condition, appear in Table 8.

All items in the sentence recognition tests related to particular vocabulary manipulations. Thus, the explanations of the few interpretable differences that were found must be viewed with the qualification that many quite strong differences in the text were not associated with differences in correct recognition rate. Sentence 1 in Table 8 shows some advantage for the easy and difficult-unimportant versions. In both of these versions, the relevant section of the text is:

> . . . people began to worry about the fact that all three fuels would be gone one day. People began to think about finding new ways to get energy.

This is a superordinate notion in the text, serving to introduce descriptions of the various "new ways." In the difficult-importance form of the passage,

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Insert Table 8 about here.

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the section was transformed into the following:

> . . . people universally began to feel consternation about the prospect that all three would be depleted one day. People commenced thinking about devising original techniques for procuring energy.

This high rate of difficult vocabulary probably accounted for the decrement of performance on the difficult-important version.

In contrast, Sentence 2 entails an advantage for the difficult-important form. This sentence appeared identically in the easy and difficult-important forms but was manipulated in the difficult-unimportant form to contain (falling)/descending, (just like)/similar to, and (turn)/rotate. The performance on the easy form was poorer than expected, but the effects seem related to vocabulary difficulty. Sentence 3 displays an advantage for the easy form over the other two. Difficult vocabulary appears in the difficult-unimportant version for this item (used/harnassed, grind/pulverize). In contrast to Sentence 2, this suggests a general decrement arising from the appearance of difficult vocabulary in important propositions.

All three recognition items in Table 8 relating to "The Sea" were drawn from sections in the text in which difficult vocabulary was used in the difficult-unimportant forms. The performance on difficult-unimportant forms shows a different relation to performance on the other forms. Since identical wording was used in easy and difficult-important forms, a specific-effects hypothesis would predict the results for Sentence 5. In the text, easy and difficult-important passages contained the proposition. Most sea plants are tiny. In the difficult-unimportant form, the corresponding sentence reads: The bulk of sea flora are minute. Similar patterns of text differences obtain for Sentences 4 and 6, but

the patterns of results differ. No explanation is available for Sentence 4, while a general decrement hypothesis will account for the results on 6.

In the sentence recognition test for "Costa Rica," there were clear differences in performance on two items. Both related to sections of text which contained difficult vocabulary in the difficult-unimportant form of the passage. Sentence 7 suggests a possible pervasive effect of difficult vocabulary effect in the difficult-important form, while Sentence 8 indicates a more particular effect (i.e., in the difficult-unimportant form only). Both patterns have occurred sufficiently often to indicate the need for both kinds of explanations of vocabulary effects on sentence recognition. It remains for future research to examine more precisely the conditions leading to one or the other effect. The distinction may be related to the inferability of a proposition, some particular aspect of its importance, or its relationship to highly important propositions. The present data can merely suggest the existence of both types of effects rather than explaining the phenomenon.

One clear conclusion is of interest: The match of students' summaries was enhanced by the inclusion of difficult vocabulary in unimportant propositions. A parsimonious explanation of this result is that students did not process many of the unimportant items, lightening the load in terms of length and serving to help them focus on more important items which would be more useful in the formation of summaries.

Some specific findings on the sentence recognition measure support the contention that in the difficult-unimportant condition at least, difficult vocabulary was skipped, or, at least, not processed deeply. The effect of difficult vocabulary in important propositions is less clear. There is evidence that the effect generalizes in decreasing retention of other, less important items. Summary scores are reliably low, and on particular items in the sentence recognition task, propositions in the text that were identical to those in the easy condition of the text were associated with substantially poorer performance.

General Discussion

It takes a surprisingly high proportion of difficult vocabulary items to create reliable decrements in performance on these measures of comprehension. Only when one substance word in three was changed to a low-frequency synonym did performance deteriorate reliably across the passages used in Experiment 1. There are a number of possible explanations. The two major contenders are, first, that the measures used were not sufficiently sensitive to all but the grossest vocabulary effects; and, second, that normal text is so redundant that some working hypotheses about the meaning of the text can be developed and maintained even when there are many unfamiliar words, and moreover, that these hypotheses are usually quite accurate. These factors could also be working in combination. That is, students may have been able to construct partial recalls based on inferences from those aspects of the texts they did comprehend,

and these may have been sufficient to level performance on these measures. This suggestion is reinforced by the fact that a significant effect for vocabulary difficulty was found only on the sentence recognition measure.

A parsimonious explanation of vocabulary effects is that rather than spending cognitive effort attempting to hypothesize about the meanings of unfamiliar words, as a model based on Rumelhart (1977) would suggest, the reader simply skips the unfamiliar word and proceeds. Then, at the point of being tested, he or she reconstructs a digest from partial memory of the passage and from general knowledge, or tests assertions in a probabilistic fashion. That is, it may be that at the point of comprehension the reader attempts to commit as little effort as possible to the proposition-by-proposition encoding of the text. A rare word is a clear signal to the reader that effort will be needed to interpret the proposition. By this "minimum effort principle," the reader will avoid deep processing of such words as much as possible, without loss of the main themes of the passage.

The signaling value of rare words is high. Although no data are available, it is probably the case that in naturally occurring prose the frequency of words that are unfamiliar to us in a passage helps us predict that the overall theme will be unfamiliar and that the syntactic complexity of the passage may be greater than we are used to. It may also be the case that, particularly for school texts, writers do not use rare words trivially, in peripheral propositions, whose meanings cannot be constructed from elsewhere in the text. If these hypotheses are accurate,

then the appearance of rare words informs the reader first that the passage will be unfamiliar and difficult to process, and second, that, with luck, the information contained in the rare words will be available, in a more accessible form, elsewhere in the text. Consequently, effort may not be expended with the onset of each unfamiliar word. In fact, the salience of unfamiliar words may cause the reader to skip such words or even whole propositions containing such words which are judged, on some other grounds, to be difficult or not vital to the progress of the theme. These are conjectures which require testing.

The "minimum effort principle" would predict that the presence of difficult words in important propositions would result in substantial losses at the point of comprehension. The reader would either skim over important information or need to expend effort hypothesizing about the meanings of unfamiliar words. When difficult vocabulary is encountered in trivial propositions in the passage, little effort would be expended computing word meanings and little disruption would ensue. This effect is demonstrated on summarization measures only. The presence of difficult vocabulary in any proposition had significant effects on recall, hinting at a generalized disruption.

The assertion that familiarity of vocabulary affects comprehension is a truism in the boundary condition: When we read a text in an unfamiliar foreign language, our lack of knowledge of the words has alarming effects on our comprehension. The issue of the effects of some unfamiliar

words in passages written in the reader's native tongue is not so clear. It has been shown that a surprisingly high proportion of unfamiliar words is needed before a reliable effect on product measures of comprehension is evident, and that the presence of difficult vocabulary in propositions of varying levels of importance has equivocal effects. The exception to the latter finding is that difficult vocabulary in trivial propositions leads to more adult-like summarization than does difficult vocabulary in important propositions. It remains for further research to examine vocabulary effects on on-line process measures and correlates of comprehension, and to particularize those local and global aspects of texts which facilitate hypotheses about the meanings of unfamiliar words.

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Footnote

Reprints and copies of the passages used in these experiments are available from the first author, Centre for Behavioural Studies in Education, University of New England, Armidale, N.S.W., Australia 2351.

Table 1

Partitioning of Variance and Significance Tests for All Dependent Measures (Experiment 1)

Source	df	Total Recall		Arcsin Summary		Detail Recognition		Main Recognition		Total Recognition	
		% Var	F	% Var	F	% Var	F	% Var	F	% Var	F
Between											
Ability	1	17.74	16.69**	11.12	11.18**	13.82	13.80**	24.06	23.58**	25.66	27.52**
Group	8	6.40	<1	17.69	2.22	15.36	1.92	6.60	<1	9.58	1.28
Square	2	4.65	2.19	4.55	2.29	3.74	1.87	.98	<1	2.29	1.23
Error	67	71.21	--	66.64	--	67.08	--	68.36	--	62.47	--
Within											
Passage	8	10.69	1.76	16.22	2.92*	8.09	1.29	22.20	4.39**	19.45	3.65**
Vocabulary	1	2.40	3.16	.44	<1	1.49	1.91	2.12	3.35	2.63	3.94**
Vocabulary x Passage	8	1.25	<1	4.24	<1	3.77	<1	3.08	<1	2.79	<1
Vocabulary x Ability	1	.01	<1	.17	<1	.08	<1	.25	<1	.22	<1
Passage x Ability	8	1.53	<1	1.00	<1	.58	<1	1.10	<1	.75	<1
Vocabulary x Group	8	.59	<1	1.46	<1	.05	<1	1.72	<1	.79	<1
Residual	110	83.53	--	76.47	--	85.94	--	69.53	--	73.37	--
$P(B)$[a]		.5337		.3539		.3285		.3483		.3584	

[a] $P(B)$ indicates the proportion of total variance attributable to between-subjects effects.

*$p < .05$ **$p < .01$

Table 2

Regression Weights (B) and Means for Ability and Vocabulary Effects on All Dependent Measures (Experiment 1)

	Recall	Arcsine P (Summary)	Detail Recognition/6	Main Recognition/4	Total Recognition/10
Ability (Regression weights [B])	1.24**	.05**	.30**	.37**	.68**
Vocabulary (Means)					
Easy	5.27	.19	4.34	2.77	7.11*
Medium	4.90	.17	4.15	2.57	6.72
Difficult	3.99	.17	4.01	2.46	6.47

*$p < .05$

**$p < .01$

Table 3

Mean Number of Propositions Recalled
for the Nine Passages Used in Experiment 1,
for Three Levels of Vocabulary Difficulty

Passage	Vocabulary Level		
	Easy	Medium	Difficult
Supermarket	6.75	8.80	4.57
The Sea	4.71	4.63	3.30
Costa Rica	6.20	4.71	5.38
Sing-Sing	4.50	3.70	3.13
Horseshoes	4.88	6.50	4.50
Fuels	6.50	3.38	5.50
Sweden	5.10	3.25	1.90
Huta	6.00	5.70	5.00
Trade Laws	2.80	3.00	3.00

Table 4

Mean Number of Propositions Recalled for Three Levels of Vocabulary Difficulty and Three Positions (Experiment 1)

Position	Vocabulary		
	Easy	Medium	Difficult
1st	6.76	5.43	4.13
2nd	4.77	5.12	4.69
3rd	4.83	3.46	3.04

Note: N's per cell vary from 28 to 32.

Table 5

Partitioning of Variance and Significance Tests for Three Measures of Retention (Experiment 2)

Source	df	Total Recall		Summary		Recognition	
		Percentage of Variance	F	Percentage of Variance	F	Percentage of Variance	F
Between							
Ability	1	38.54	42.08**	16.57	13.30**	21.06	17.88**
Group	2	.09	<1	nil	<1	nil	<1
Residual	67	61.37	--	83.44	--	78.94	
Within							
Passage	2	11.47	14.37**	6.22	4.16*	18.85	19.36**
Position	2	.86	1.08	1.79	1.20	1.91	1.96
Vocabulary Contrast	1	5.85	14.66**	.54	1.35	.96	2.41
Importance Contrast	1	.14	.35	8.10	20.30**	2.61	6.54*
Vocabulary x Passage	2	2.01	2.52	.73	<1	.53	<1
Vocabulary x Position	2	10.77	13.50**	1.36	<1	7.40	7.60*
Importance x Passage	2	.93	1.17	.57	<1	.89	<1
Importance x Position	2	12.14	15.21**	2.27	1.52	.02	<1

Table 5 (continued)

Partitioning of Variance and Significance Tests for Three Measures of Retention (Experiment 2)

Source	df	Total Recall		Summary		Recognition	
		Percentage of Variance	F	Percentage of Variance	F	Percentage of Variance	F
Between							
Ability x Passage	2	2.84	3.56*	3.13	2.09	.84	<1
Ability x Position	2	2.97	3.72*	.73	<1	7.24	7.43**
Vocabulary x Ability	1	2.17	5.44**	.09	<1	.75	1.54
Importance x Ability	1	.03	<1	.66	<1	.22	<1
Group x Passage	4	.99	<1	.29	<1	2.54	1.30
Group x Position	4	.54	<1	3.09	1.03	1.84	<1
Position x Vocabulary x Ability	2	1.81	2.27	.32	<1	2.66	2.73
Position x Importance x Ability	2	2.96	3.71*	.38	<1	.08	<1
Residual	104	41.50	--	77.81	--	50.64	--
P(B)		.6870		.4407		.4876	

*p < .05

**p < .01

Table 6

Regression Weights (B) and Means for Significant Effects and Effects of Interest (Experiment 2)

	Total Recall	Summary	Recognition
	Ability		
Regression Weights (B)	1.12*	.10**	.03**
	Vocabulary		
Easy	6.96**	1.00	.69
Difficult	5.79	.91	.67
	Importance		
Difficult-Unimportant	5.90	1.13**	.65*
Difficult-Important	5.68	.69	.69
	Vocabulary x Position		
Easy			
Position			
1st	6.63**	1.00	.68**
2nd	8.86	1.24	.77
3rd	5.73	.81	.63
Difficult			
Position			
1st	6.11	.96	.68
2nd	5.26	.92	.66
3rd	6.04	.84	.67

Table 6 (continued)

Regression Weights (B) and Means for Significant Effects and Effects of Interest (Experiment 2)

	Total Recall	Summary	Recognition
	Importance x Position		
Difficult-Unimportant			
Position			
1st	7.64**	1.36	.67
2nd	5.20	1.20	.63
3rd	5.04	.92	.65
Difficult-Important			
Position			
1st	4.76	.60	.70
2nd	5.32	.72	.68
3rd	7.19	.76	.69

Note: Unless otherwise indicated, values given represent means.

*$p < .05$

**$p < .01$

Table 7

Mean Inclusion Rates for Propositions in Summaries (Experiment 2)

Proposition	p(inclusion)
"Fuels"	
1. We rely on fuels such as petroleum etc.	.197
2. These are dangerous to the environment	.099
3. We are running out	.366
4. People are trying to devise new sources (e.g., windmills etc.)	.394
"Sea"	
1. The sea is vast and important	.268
2. Its animals and plants (are vital in the life system)	.296
3. It is being polluted	.408
4. People are attempting to stop this	.057
"Costa Rica"	
1. Costa Rica is in Central America	.141
2. It has fertile soil, and thus a farm economy	.296
3. It exports certain products (e.g., sugar and coffee)	.183
4. It has undeveloped resources	.085

Table 8

Selected Items From the Sentence Recognition Test

Showing Differences Related to Vocabulary (Experiment 2)

Item	p(correct)		
	Easy	Difficult in Unimportant	Difficult in Important
"Fuels"			
1. People began to worry about new ways to get energy.	.92	.88	.72
2. Falling water, just like wind, can cause blades to turn.	.79	.71	1.00
3. Windmills have been used to crush grain.	.83	.58	.64
"The Sea"			
4. Water is evaporated only once from the sea.	.67	.79	.92
5. Most sea plants are very small.	.63	.38	.63
6. Wastes began showing up in the flesh of sea animals.	.71	.58	.54
"Costa Rica"			
7. Lumbering is a very significant industry in Costa Rica.	.88	.58	.58
8. Columbus traveled along the country's Atlantic shore.	.72	.42	.71

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